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(71) Applicant *(for all designated States except US)*: RHEEM AUSTRALIA LIMITED [AU/AU]; Brodie Street, P.O. Box 6, Rydalmere, NSW 2116 (AU).

(72) Inventor; and
(75) Inventor/Applicant *(for US only)* : BOURKE, Brendan, Vincent [AU/AU]; 24 Macaulay Road, Stanmore, NSW 2048 (AU).

(74) Agent: TILLEY, A., W.; Rheem Australia Limited, Brodie Street, P.O. Box 6, Rydalmere, NSW 2116 (AU).

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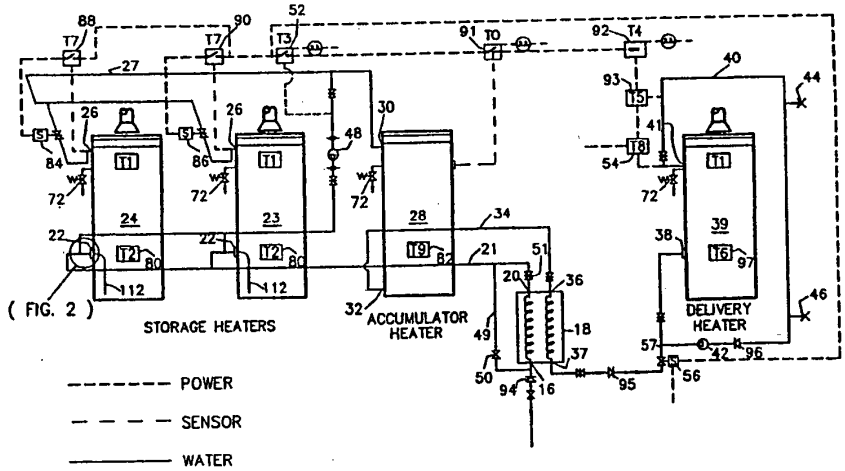
(54) Title: WARM WATER SYSTEM



(57) Abstract

Apparatus to supply warmed water for human washing and adapted to provide protection both against undesirably high levels of pathogenic organisms of the species Legionella in said water and against risk of scalding by said water. The apparatus comprising an enclosed water mains pressurised first flow path for cold water (21), a first storage water heater, to heat the cold water and maintain it at a first high temperature effective in destroying said organisms, consisting of storage heaters (23, 24), accumulator heater (28), hot water circulation loop (27), and temperature control means (52, 80, 82, 88, 90) adapted to maintain said high temperature, a second flow path (34) intercommunicating between said first storage water heater and a second storage water heater, indirect heat exchange means (18) between said first (21) and second flow paths (34), said second storage water heater consisting of delivery heater (39), warm water circulation loop (40), heating means adapted to heat the water in said second storage water heater to a second, lower temperature, and temperature control means (54, 92, 93, 97) adapted to maintain said lower temperature at a precise pre-determined value required for washing at an outlet (44, 46) provided and supplied from said warm water circulation loop (40).

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WARM WATER SYSTEM

BACKGROUND

This invention relates to storage type hot water systems and in particular to systems designed to supply warm as distinct from hot water. It more particularly relates to gas fuelled warm water systems but is not limited thereto.

A warm water system having similar attributes to this present invention is subject of our published co-pending Australian patent application 13107/88 and this specification imports the earlier specification by reference. The common purpose of both is to provide a supply of warm water free of Legionella pathogens to the extent that no health or scalding risk obtains when using the warm water for bathing or showering.

The present invention is advantageous in application to storage type gas fuelled water heaters whereas the earlier invention is more suited to electrically heated types.

The invention relies upon first storing the water to be used in a first, mains-pressure type, storage tank or group of interconnected tanks, hereinafter referred to as the first storage, at a temperature effective in destroying Legionella which may have been admitted in the incoming mains water. A further provision is a heat exchanger in the hot water outlet of the first storage, the heat exchanger being selected from the types where at least one wall separates two flows of liquid exchanging heat with one another while flowing through the exchanger. A further provision of the system is a second storage tank or group of interconnected tanks, hereinafter referred to as the second storage, also of the mains pressure type, where water from the first storage, having been cooled to a temperature slightly below that used for human bathing by passage through the heat exchanger, is reheated to the temperature required for comfortable human bathing and stored for use in the second storage with no further mixing with cold water at the point of use. The second storage is provided with heating means controllable by thermostat

means to raise if necessary and maintain the water in the second storage to a temperature sufficient to provide a comfortable showering or bathing temperature at the point of use.

Such temperature is usually in the region of 40 to 43° C which is a temperature ideal for the rapid multiplication of the pathogen Legionella. Therefore it is essential that no Legionella organisms remain in a viable state in the water after it leaves the first storage.

The water flowing from the first storage to the second is cooled by exchange of heat with mains water flow entering the first storage to make up its volume on each withdrawal of warm water at the point of use.

Due to the requirement to provide the outlet or outlets with substantially closely temperature controlled warm water, it is necessary to avoid the marked thermal stratification which would normally occur in the first storage if it comprises one or more gas heated storage type heaters. Since in such situations as require the present invention it is quite possible that the users of washing facilities are physically or mentally incapable of adjusting water temperature by the normal act of adjustment of the hot and cold taps, thermal stratification to a considerable degree could result in an unacceptable uncontrollably of the outlet temperature. Therefore means are provided in the present invention to substantially limit thermal stratification in the higher temperature storage tanks. Preferably means are provided whereby water in the first storage is accumulated at the higher temperature for an extended time before entering the heat exchanger.

SUMMARY

he invention consists of apparatus to provide warm water for human washing and adapted to provide protection both against the possibility of significant levels of pathogenic organisms of the species Legionella in said warm water and against risk of scalding, said apparatus comprising an enclosed water

mains pressurised first flow passage to permit flow of cold water to a first storage, heating means adapted to heat the water in said first storage to a thermal destruction temperature effective in destroying said organisms, a temperature control means adapted to maintain the first storage at the thermal destruction temperature, a circulatory pumped circuit for mixing the water in the first storage, heated water accumulation means as a component of said first storage, an intercommunicating passage to permit flow between the first and a second storage, indirect heat exchange means between the first and second flow passages, heating means adapted to heat the water in said second storage to a warm washing temperature substantially below the thermal destruction temperature, a circulatory warm water pumped circuit for mixing the water in the second storage to maintain the warm washing temperature substantially uniform throughout the second storage and the warm water circulatory pumped circuit, temperature control means adapted to maintain the warm washing temperature at a substantially accurate pre-determined value, at least one single-tap washing outlet branching off the warm water circulatory circuit, said warm washing temperature being adjusted such that the water temperature at the outlets is within the range required for human comfort when bathing or showering despite the deliberate avoidance of any provision for mixing of the warm water with cold water between the second storage and the washing outlets.

Preferably the accumulation means is arranged to delay the water at the thermal destruction temperature for a prolonged time.

DESCRIPTION OF THE DRAWINGS

In order that the present invention may be more clearly understood a particularly preferred embodiment and variations thereof of apparatus in accordance with the invention will now be described. The ensuing description refers to non-limiting examples only, as illustrated in and described with reference to - the accompanying drawings in which Fig 1 is a schematic circuit diagram of a apparatus for providing warm water according to the present invention.

Fig 2 is an enlarged detailed view of a component of Fig 1.

DETAILED DESCRIPTION

Referring to Fig 1, incoming mains pressure cold water enters the system at inlet 16 of countercurrent flow heat exchanger 18, which is an indirect type where two opposing flows of fluid exchanging heat are physically separated. A plate heat exchanger is a suitable type although other types of indirect heat exchange such as the shell and tube type could be used.

The outlet 20 of the heat exchanger from which emerges the water entering at inlet 16 is connected via water entry line 21 to a water inlet opening 22 of each of two gas fuelled, storage type, mains pressurised water heaters 23 and 24, comprising in this example of the invention, two identical 290 litre capacity heaters, each heated by a 190 megajoule gas burner (not shown).

Each outlet 26 of water heaters 23 and 24 is connected to and is part of hot water circulation loop 27 which in turn has a connection with a top opening 30 of a third water heater referred to as the accumulator heater 28 in the group of 3 heaters shown which in total are described as the hot water storage. Accumulator heater 28 is electrically heated. Outlet 32 of accumulator heater 28 is connected via hot water passage 34 to an inlet 36 for hot water of the heat exchanger 18. From outlet 37 of the heat exchanger 38 water can proceed via a connection to further heater (referred to as a delivery heater) 39. Delivery heater 39 is equipped also with a 190 magajoule gas burner (not shown).

A pumped warm circulation loop 40 is provided joining delivery heater inlet 38 (or close to inlet 38) to delivery heater outlet 41. Circulation within the warm water circulation loop 40 is by an electrically powered pump 42 and two warm water outlets 44 and 46.

A second circulation pump 48 is provided to circulate hot water in circulation loop 27 from the outlets 26 and the inlets 22 of each storage heater 23 and 24.

A bypass loop 49 is provided to bypass the increasing temperature side 16 to 20 of the heat exchanger 18, the loop including a normally closed valve 50. The bypass loop is provided to enable the entire system from heater outlet 32 to warm water outlets 44 and 46 to be purged with water at the thermal destruction temperature. With valve 50 opened and normally open valve 51 closed, the hot water entering at 36 the heat exchanger 18 is not cooled and so enables the delivery heater 39 and warm water circulation loop 40 to be purged both at installation and at times of routine maintenance.

A temperature sensor 52 is provided in thermal contact with a point in the hot water circulation loop 27.

A temperature sensor 54 is provided in thermal contact with any convenient point in the warm water circulation loop 40.

A solenoid operated shut-off valve 56 is provided in the warm water line prior to the point 57 where it joins with the warm water circulation loop 40.

Storage tanks 23, 24, 28 and 39 are provided with the obligatory over temperature and over pressure relief valves 72. More than one such valve per heater may be desirable.

Temperature sensing thermostats are provided as follows and are illustrated schematically on Fig 1. In Fig 1 the thermostats are indicated by a rectangle and the letter T with subscripts 0 to 9 inclusive. Where particularly discussed elsewhere in relation to the operation of the warm water system of this invention the thermostats are numerically designated as well. Those thermostats, T1, T2, T6 and T9 illustrated on the water storage tanks 23, 24, 28 and 39 are physically positioned in contact with the external wall of the tanks approximately as shown. Thermostats T1 perform the function of over-temperature safety cut-out in the gas heated tanks 23, 24 and 39. They are set typically 5^{O} C above the normally intended tank temperature. The thermostats T2 and T9 are used to set the normally intended tank temperature.

Thermostat 91 is the normally open type and has its sensor immersed in the top of accumulator heater 28 and has a set point of 70° C. On closing, thermostat 91 energises the heating element in accumulator heater 28. Thermostat 52 is the normally open type and has a set point of 75° C and has its sensor immersed in the hot water circulation loop 27. On closing, thermostat 52 energises pump 48.

Thermostat 90 is the normally open type, has a set point of 75° C and has its sensor immersed in the top of storage heater 23. On closing it actuates solenoid valve 86 to admit hot water from storage heater 23 to the hot water circulation loop 27.

Thermostat 88 is identical to and, is identically set to thermostat 90. On closing it actuates to admit hot water from storage heater 24 to the hot water circulation loop 27.

Thermostat 54 has its sensor immersed in the warm water circulation loop 40 and has a set point of 42° C and has a small differential of 1°C.

Thermostats 92 and 93 both have sensors immersed in the warm water circulation loop and are normally closed, opening if the temperature in the loop exceeds 46° C. Thermostats 92 and 93 upon opening cause solenoid valve 56 to close. Thermostats 92 and 93 are series interconnected in order to provide a back-up in the event of malfunction of either one.

Thermostat 97 is a normally closed contact type fitted to contact toward the lower end of the delivery heater 39. It has a set point of 46° C and an unusually large differential of 15° C.

In the warm water circulation loop a non- return valve 96 is fitted to prevent flow other than in the direction from the outlet 41 to the inlet 38 of heater 39.

In the warm water line from the heat exchanger 18 outlet 37 to the warm water circulation loop 40 a non-return valve 95 is fitted preventing reverse flow in the event that a malfunction were to cause over-pressure build up in the delivery heater 39.

A non-return valve 94 is fitted in the cold water mains inlet which prevents hot water being forced back into the mains in the event of a failure of both temperature and pressure relief valves in the storage heaters 23 and 24.

With reference to Fig 2, the inlet fitting 100 is shown which is connected at the inlet to each heater 23 and 24 in order to enable recirculation and uniformity of temperature within the heaters 23 and 24. The inlet fitting 100 comprises an inner tube 102 contained within an outer tube 104. The outer tube 104 is connected by any suitable leak-tight joining method to the heater inlet fitting 22. The inner tube 102 is extended beyond the open end 106 of the outer tube 104 and is curved to extend to a point very close to the bottom end of the heaters 23 and 24 (as the case may be). The end 108 of the outer tube opposite the open end 106 is sealed around the inlet tube 102. Outer tube 104 has a branch pipe 110 entering it at a point between the open end 106 and closed end 108. Inlet pipe 102 is open at both ends, the end 112 being inside the heater and the end 114 outside. Branch pipe 110 is open at its end 116. When installed in the warm water system, the inlet fitting 100 has the inlet end 114 of inner pipe 102 connected to the water entry line 21 and the inlet end 116 of the branch pipe 110 connected to the hot water circulation loop 27.

Referring to Fig 1 the normal operation of the system is as follows. All temperatures are in degrees Celsius, abbreviated C.

The system is initially filled with water at mains pressure.

he warm water system is operated by opening valve 44 and/or 46 when water is required for bathing.

Incoming water enters the system at inlet 16 to the heat exchanger 18. As water is withdrawn from the system at valves 44 or 46 mains water entering the system replenishes it.

The water in each tank 23 and 24 is heated by a gas burner to a temperature approximating 82° C. Pathogenic organisms, such as the species Legionella, which may be present in the incoming water are known to be destroyed at a temperature of about 75° C within thirty seconds.

Heat exchanger 18 passes equal counter-current mass flows through both sides, from 16 to 20 (cold side) and 36 to 37 (hot side).

Since an approximately 40°C to 45°C temperature fall (at least) is required between the hot water and warm water circulation loops, therefore an equal temperature rise of the cold inlet water is a consequence. Entering the cold side of the heat exchanger 18 the water temperature is not more than about 30° C. After passing through the cold side of the heat exchanger 18 it therefore rises to a temperature of approximately 55° C maximum. It is preferable to configure the system in such a manner that the fall in temperature of the hot water takes its temperature to below 43° C, ensuring that some relatively small amount of heating of the water in delivery heater 39 will always be required when warm water is being withdrawn. Otherwise it would be likely that the water in warm water circulation loop 40 could be at a temperature above that required for comfort. It is preferable to balance the system components such that heating is always required, since it is possible to bring the water temperature in loop 40 to the required value far more quickly than natural cooling loss from the warm water circulation loop 40 would enable lowering of the temperature if the water leaving the heat exchanger outlet 37 were too warm.

Water contained in the delivery heater 39 is heated by a gas burner (not shown) to a temperature in the order of 43° C, which is the maximum required for comfortable showering and bathing without intermixing with cooler water. In fact, the temperature required in the delivery heater 39 needs to

be precisely controlled because the temperature comfort requirements for warm water in the present context is within quite narrow limits, typically 41 ± 1°C at the point of use. Water contained in delivery heater 39 is continuously circulated through circulation loop 40 from the heater outlet 41 to the inlet 38.

Heat loss from the warm water circulation loop 40 when the system is at a steady state may require a thermostat 54 enabling the water temperature in the delivery heater 39 to be slightly adjusted on a seasonal basis to ensure optimum temperature at the outlets 44 and 46. The differential of this thermostat is selected to be very small (eg 1°C) so that the temperature of water circulating in the delivery loop in kept within the required narrow limits.

In order to further assist controllability of the temperature of the water in the warm water circulation loop 40 it is desirable to limit the fluctuation of temperature of water entering the warm water circulation loop 40 from the hot side outlet 37 of the heat exchanger. Therefore the hot water in heaters 24 is continually circulated in hot water circulation loop 27, whereby hot water from outlets 26 is circulated by pump 48 to return to the heaters via the inlets 22. This circulation results in substantial uniformity of temperature throughout each heater 23 and 24 and the hot water circulation loop 27. In the absence of circulation the water in heaters 23 and 24 would be thermally stratified so causing an unacceptable amount of fluctuation of temperature of the water leaving the heat exchanger and entering the warm water circulation loop 40.

Therefore the provision of circulation loop 86 is important in enabling adequate controllability of temperature of water available to the user at valves 44 and 46.

he temperature control thermostats 80 of each heater 23 and 24 are set to stop the heating up of that individual heater at about 82° C.

The system is provided with means to overcome incorrect, unsafe or abnormal operating conditions in the following ways:-

In order to ensure that all incoming water has been heated to 75° C, referred to in this context as the thermal destruction temperature, before passing out of the hot water circulation loop 27, temperature sensors 88 and 90 are arranged to also monitor the heaters 23 and 24 individually to send a signal in the event of too low a temperature in the respective heater. Should less than the thermal destruction temperature be sensed by the sensors 88 and 90 an electrical signal is sent to solenoid valve 84 or 86 to close off further hot water from entering into the warm water circulation loop 40. If one of the storage heaters fails to operate at the set point temperature its output of hot water will be closed off from entry to the hot water loop 27.

Improved residence time is achieved in the heaters 23 and 24 by directing the incoming water entering at inlets 22 through an extended dip tube 102 such as to enter the heater as close as possible to the bottom of the heater at 112 (Fig 2). Since the water entering is cooler than that circulating in hot water loop 27, density differences help to ensure that incoming water will not preferentially tend to rise to the outlets 26 until adequate time has elapsed to reach the thermal destruction temperature and to remain at it, probably for at least 30 seconds.

If circumstances should for any reason arise, such as a particularly rapid draw-off of water from the system, that causes the water heated in heaters 23 and 24 to have not resided at the thermal destruction temperature for at least 30 seconds, then the accumulator heater 28 is able to prolong the residence time adequately. To maximise the residence time in the accumulator heater 28 the water entering from hot water circulation loop 27 is introduced into an inlet high in the tank, namely inlet 30, and withdrawn from an outlet 32 relatively low in the tank. Furthermore, the thermostat 82 is set at 75°C so that water heated by the electric element (not shown) located in the accumulator heater at a point lower than thermostat 82, after a period of no draw off of water from the warm water loop 40, will tend to exert a buoyant

upward force on water entering at inlet 30 at a temperature not less than 75°C and probably 82°C in the normal course of events. By adopting this procedure, accumulator heater 28 requires no internal baffles or divisions by which to prolong the residence time therein.

A second type of incorrect operating condition may arise if the temperature in the warm water circulation loop 40 is too high. This would present the risk of discomfort or scalding by water at outlets 44 and 46. This possibility is obviated by the provision of temperature sensor 93 in loop 40 whereby when any temperature above about 46° C is sensed, the sensor causes valve 56 to close off water entry to the warm water circulation loop 40.

Thermostat 97 on delivery heater 39 has a set point of 46°C and an unusually large differential of 15°C. Thus, if the water temperature does cause the thermostat to switch it requires manual resetting thus encouraging investigation of the reasons for malfunction of the primary means of temperature control, namely thermostats 54, 93 and 92.

Having described the invention in terms of the above preferred embodiment and variations thereof it will be apparent to those skilled in the relevant arts that many minor variations may be made in the preferred embodiment described by way of example, including the substitution of a different number of storage tanks than the number described and illustrated, while remaining within the scope of the invention as below claimed.

CLAIMS

1. Apparatus to provide warm water for human washing and adapted to provide protection both against the possibility of significant levels of pathogenic organisms including the species Legionella in said warm water and against risk of scalding, said apparatus comprising an enclosed water mains pressurised first flow passage to permit flow of cold water to a first storage, heating means adapted to heat the water in said first storage to a thermal destruction temperature effective in destroying said organisms, a temperature control means adapted to maintain the first storage at the thermal destruction temperature, a circulatory hot water pumped circuit for mixing the water in the first storage water, accumulation means as a component of said first storage, an intercommunicating passage to permit flow between the first and a second storage, indirect heat exchange means between the first and second flow passages, heating means adapted to heat the water in said second storage to a warm washing temperature substantially below the thermal destruction temperature, a circulatory warm water pumped circuit for mixing the water in the second storage to maintain the warm washing temperature substantially uniform throughout the second storage and the warm water circulatory pumped circuit, temperature control means adapted to maintain the warm washing temperature at a substantially accurate pre-determined value, at least one single-tap washing outlet branching off the warm water circulatory circuit, said warm washing temperature being adjusted such that the water temperature at the outlets is within the range required for human comfort when bathing or showering despite the deliberate avoidance of any provision for mixing of the warm water with cold water between the second storage and the washing outlets.

2. Apparatus as claimed in Claim 1 in which the accumulation means is arranged to delay the water at the thermal destruction temperature for a prolonged time.

3. Apparatus as claimed in Claim 2 in which the accumulation means is a tank capable of being heated and in which water flowing from a first portion of said first storage is delayed for said prolonged time by the provision of an entry opening into said tank at a point higher in said tank and the provision of an exit opening from said tank at a point low in the tank.

4. Apparatus as claimed in any one of claims 1 to 3 in which said accumulation means is a tank without internal baffles.

5. Apparatus as claimed in any one of Claims 1 to 4 in which said accumulation means is provided with two thermostats sensing temperatures at two vertically spaced apart locations of the accumulator means and in which the two thermostats are provided with different set point from each other.

6. Apparatus as claimed in any preceding claim in which said first storage comprises at least one storage heater and at least one heated tank as the water accumulation means.

7. Apparatus as claimed in Claim 6 in which an inlet fitting is provided for each said storage heater in which provision is made for admitting water from the hot water pumped circuit and the water entry line in two separated streams through a single opening in a vertical wall of said heater.

8. Apparatus as claimed in Claim 7 in which the inlet fitting is provided with an inner tube capable of extending to a point close to the bottom of the or each storage heater to which it is joined and an outer tube which terminates at the tank wall.

9. Apparatus as claimed in Claim 8 in which the inner tube is configured to carry water entering the heater directly from said heat exchanger and the outer tube is configured to carry water entering the heater from said hot water circulation loop.

10. A method of providing warm water for human washing in which the water is free of the possibility of significant levels of pathogenic organisms including the species Legionella in said warm water and against risk of scalding, said method including the steps of:

(a) heating incoming water in a first heater means to at least a thermal destruction temperature effective in destroying said organisms;

(b) accumulating the heated water for a period sufficient to ensure no significant survival of said organisms following a residence time at a temperature at least equal to said thermal destruction temperature;

(c) circulating said water in said first heater means to mix said water;

(d) cooling and storing in a delivery heater the water from the thermal destruction temperature to a warm water temperature not higher than that required for optimum human comfort when washing or showering, by exchanging heat between the water being cooled and water entering the system;

(e) raising the temperature of the water in said delivery heater when necessary to maintain it at a precisely controlled temperature required for human comfort when washing or showering; and

(f) providing outlets for washing and showering using said warm water without associated outlets for intermixing cold mains water with the warm water.

11. Apparatus to provide warm water substantially as herein described and illustrated.

12. A method providing a supply of warm water substantially as herein described and illustrated.

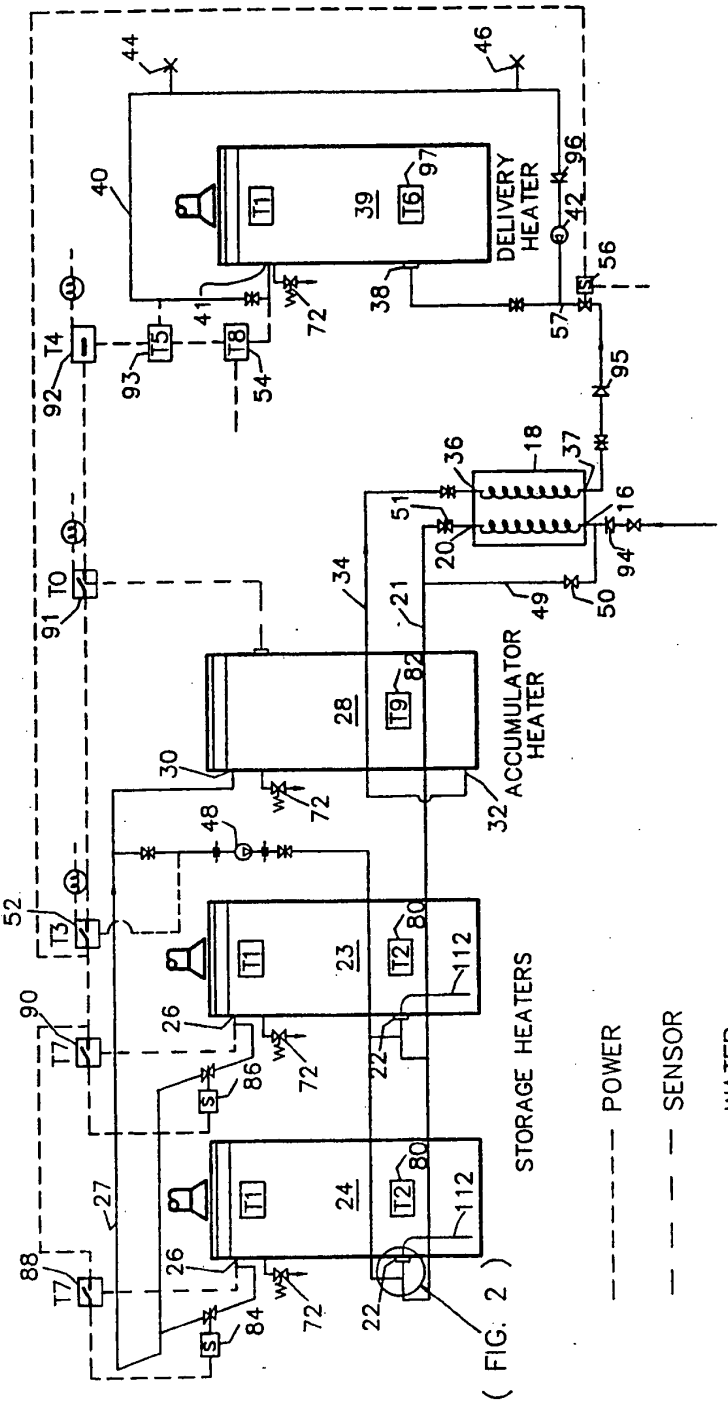
DELIVERY HEATER
ACCUMULATOR HEATER
STORAGE HEATERS
POWER
SENSOR
WATER
(FIG. 2)

FIG. 1

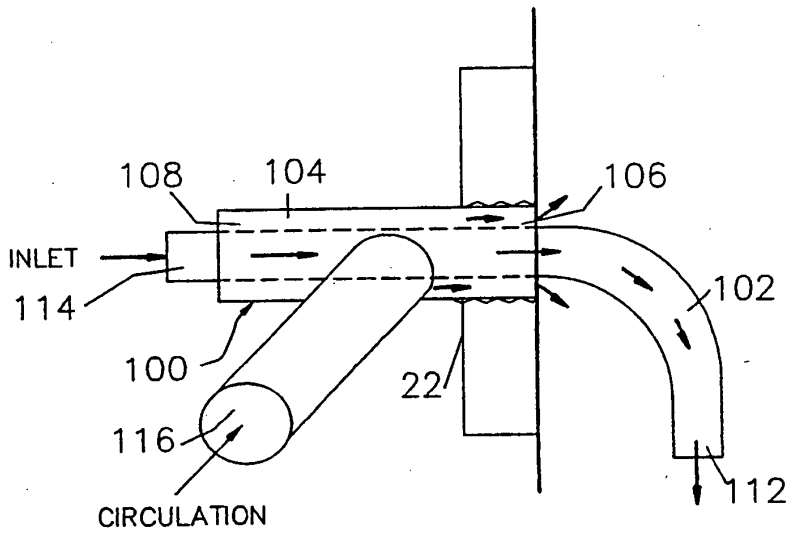

FIG. 2

INTERNATIONAL SEARCH REPORT

International Application No. PCT/AU 89/00504

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) 6

According to International Patent Classification (IPC) or to both National Classification and IPC

Int. Cl.[4] F24D 17/00, F24H 1/18

II. FIELDS SEARCHED

Minimum Documentation Searched 7

Classification System	Classification Symbols
IPC	F24D 17/00, F24H 1/18

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched 8

AU : IPC as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT 9

Category*	Citation of Document, 11 with indication, where appropriate, of the relevant passages 12	Relevant to Claim No 13
X	AU,A, 13107/88 (RHEEM AUSTRALIA LTD) 15 September 1988 (15.09.88)	(1,2,4,10)
X	GB,A, 2099559 (THE HORNE ENGINEERING CO. LTD) 8 December 1982 (08.12.82)	(1,2,4,10)
A	DE,A, 3710927 (DORFMULLER) 20 October 1988 (20.10.88)	
A	DE,A, 3641726 (VIESSMANN WERKE GmbH & CO) 9 June 1988 (09.06.88)	
A,P	DE,A, 3836523 (JOH. VAILLANT GmbH & CO) 11 May 1989 (11.05.89)	

* Special categories of cited documents: 10

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
5 February 1990 (05.02.90)	20/02/90
International Searching Authority	Signature of Authorized Officer
Australian Patent Office	R. HALLETT R. Hallett

Form PCT/ISA/210 (second sheet) (January 1985)

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON
INTERNATIONAL APPLICATION NO. PCT/AU 89/00504

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned internation search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report	Patent Family Members		
DE 3641726	EP 270993		
DE 3836523	AU 26040/88	EP 338056	WO 8903807
	AT 3215/87	AT 3263/87	AT 694/88

END OF ANNEX

CORRECTED VERSION* PCT

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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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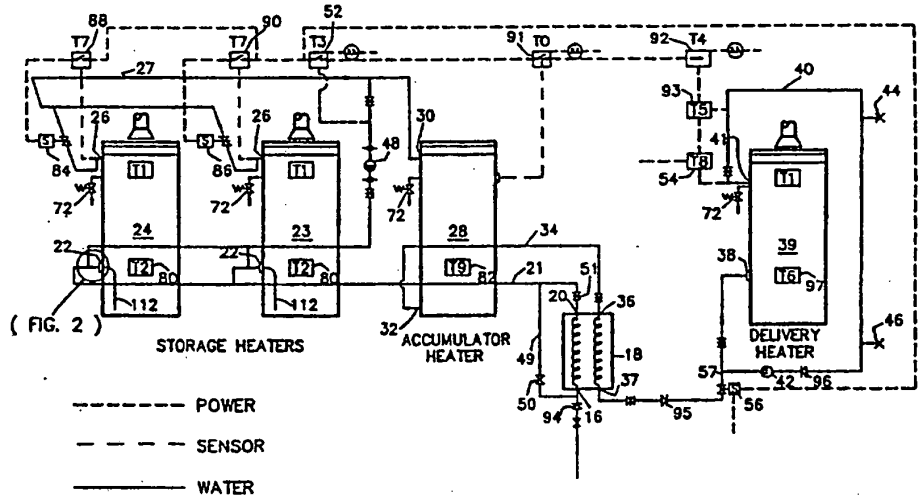

(FIG. 2)

(57) Abstract

Apparatus to supply warmed water for human washing and adapted to provide protection both against undesirably high levels of pathogenic organisms of the species Legionella in said water and against risk of scalding by said water. The apparatus comprising an enclosed water mains pressurised first flow path for cold water (21), a first storage water heater, to heat the cold water and maintain it at a first high temperature effective in destroying said organisms, consisting of storage heaters (23, 24), accumulator heater (28), hot water circulation loop (27), and temperature control means (52, 80, 82, 88, 90) adapted to maintain said high temperature, a second flow path (34) intercommunicating between said first storage water heater and a second storage wat r heater, indirect heat exchange means (18) between said first (21) and second flow paths (34), said second storage water heater consisting of delivery heater (39), warm water circulation loop (40), heating means adapted to heat the water in said second storage water heater to a second, lower temperature, and temperature control means (54, 92, 93, 97) adapted to maintain said l w r temperature at a precise pre-determined value required for washing at an outlet (44, 46) provided and supplied from said warm water circulation loop (40).

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